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National Marine Fisheries Service
2570 Dole Street
Honolulu, Hawaii

Scottish Fisheries
Information Pamphlet
Number 12 1986
ISSN 0309 9105

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Introduction

The cod-ends of seine- and trawl-nets used by Scottish fishermen are constructed normally from two sheets of netting, each 60 meshes wide, laced together. The netting is hung so that continuous twines run across the sheets and the meshes are therefore diamond shaped. Underwater television observations have shown that as the cod-end fills with fish the meshes in the central portion of the tube of netting close up under tension. The fish gather at the rear of the constricted tube creating a bulbous shape (Fig. 1 and Plate I). Young fish cannot escape through the closed meshes along the cod-end, so many juveniles are needlessly caught and destroyed.

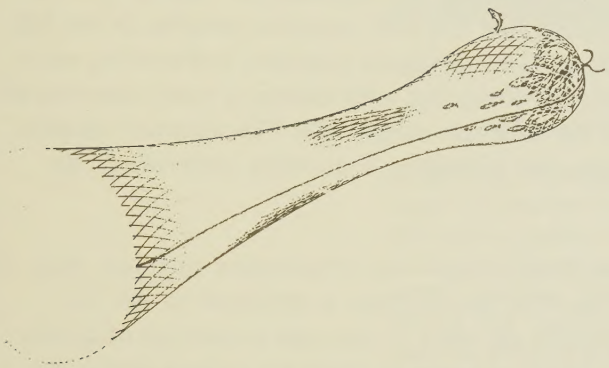

Figure 1. A schematic representation of the constriction in diamond mesh cod-ends caused by the closing of the meshes.

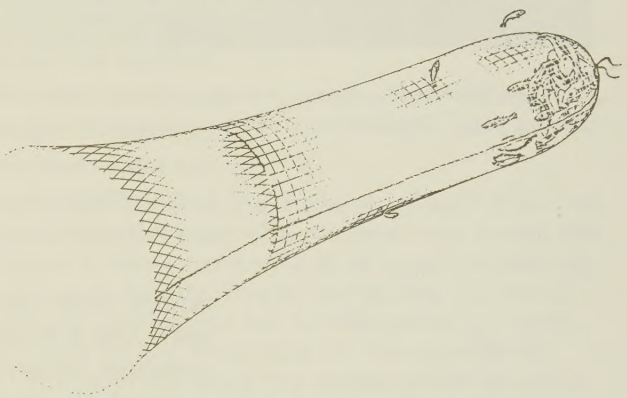

Figure 2. If rigged correctly square mesh cod-ends take up an open cylindrical shape. The possible escape area is much improved over diamond mesh.

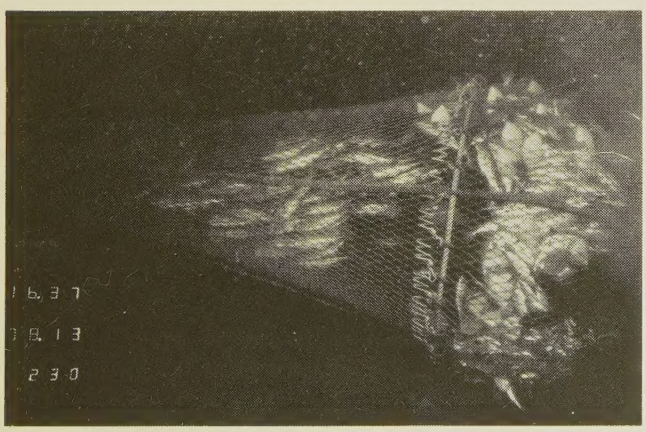

Plate I. A diamond mesh cod-end showing the constriction and closing of the meshes ahead of the accumulated mass of fish.

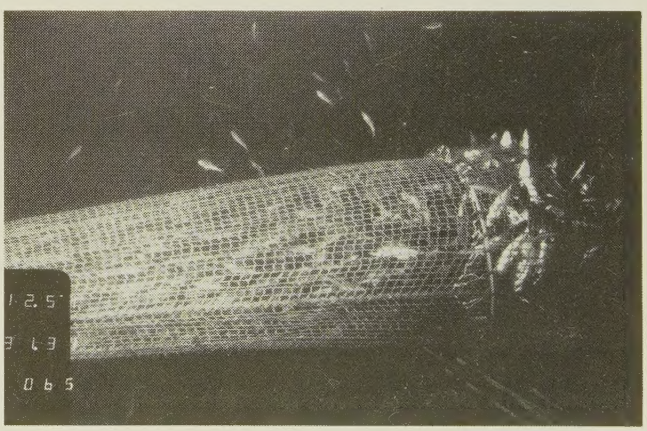

Plate II A square mesh cod-end showing open meshes through which juvenile haddock and whiting are escaping.

In an effort to reduce the catch of juvenile fish, cod-ends with square mesh have been investigated. Square meshes stay open during trawling, and the possible escape area is greatly increased so that more young fish can escape (Fig. 2 and Plate II). They are constructed from conventional diamond mesh netting but the netting is turned so that some of the netting bars are parallel to the flow and some are across the flow (Fig. 3).

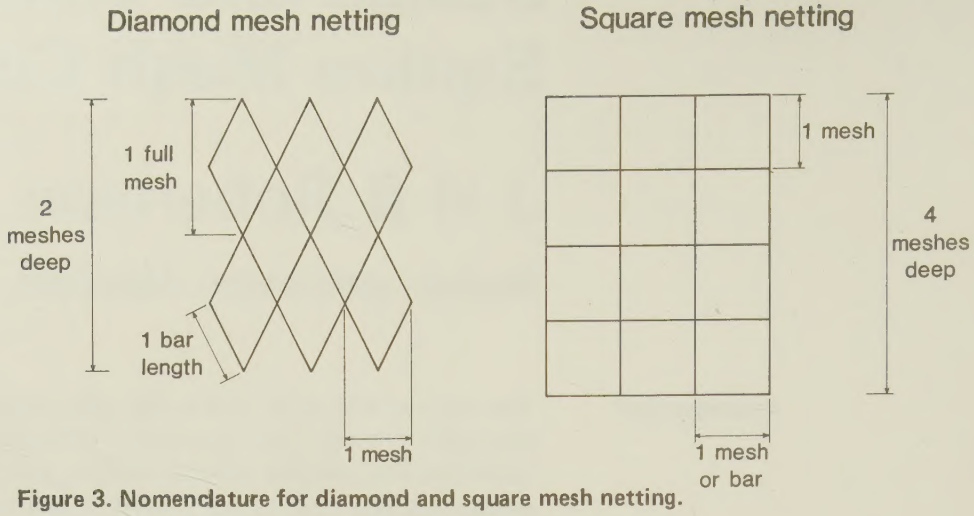

Figure 3. Nomenclature for diamond and square mesh netting.

The selectivity of square mesh cod-ends has been tested in a series of comparative fishing experiments which are fully described by Robertson (1982, 1983a & b, 1984), Robertson and Polanski (1984), Robertson, Emslie, Ballantyne and Chapman (1986) and Robertson and Stewart (1986). Although it is not the aim of this pamphlet to reiterate the results, the main findings are relevant. It was found that the 50% retention lengths (ie the fish length at which 50% of the catch is retained) for haddock and whiting were increased in square mesh cod-ends compared with diamond mesh cod-ends of the same mesh size. Further, the selection range (75%-25% selection length) for haddock in trawls was reduced indicating that more undersized fish are released.

Square mesh cod-end design, construction and attachment to trawl- and seine-nets are described below. The information is intended to aid net designers, fishermen and scientific workers. It includes a selection of underwater photographs of square mesh cod-ends to illustrate various design procedures and problems encountered in the experiments.

Design

A square mesh cod-end is described in this report as having a number of "meshes" around its mouth and along its length. The so-called meshes around the circumference are actually the number of netting bars. Likewise the length comprises a number of meshes which are each one bar length (Fig. 3). Therefore a square mesh cod-end will be described as being twice as many meshes long, for a given mesh size, as a diamond mesh cod-end. They are both, in reality, the same length when stretched out alongside one another.The mesh size of square mesh netting is measured between the opposite corners of a mesh with the netting stretched taut at right angles to the weave. This is the same procedure as for diamond mesh netting. The essential information required to design a square mesh cod-end is the number of meshes on the circumference, mesh size, twine type and material, and overall length.

The cod-ends described in this report are all constructed using two panels of netting and have a selvedge where the panels are joined on either side.

Number of Meshes on Circumference

Most Scottish trawls used currently have a section of net called the "extension" that lies between the main tapered body of the trawl and the cod-end. The extension generally has 120 meshes on its circumference and is cut back on a side knot. It can be 4 to 20 m long. The cod-end is attached to the aft end of the extension. Typically, cod-ends having 120 diamond meshes on the circumference are used to match up to the extension mesh for mesh.

However, if a square mesh cod-end having 120 square meshes (or bars) on its circumference is joined to 120 diamond meshes of the same mesh size then the result is a mismatch in circumference as demonstrated in Plate III.

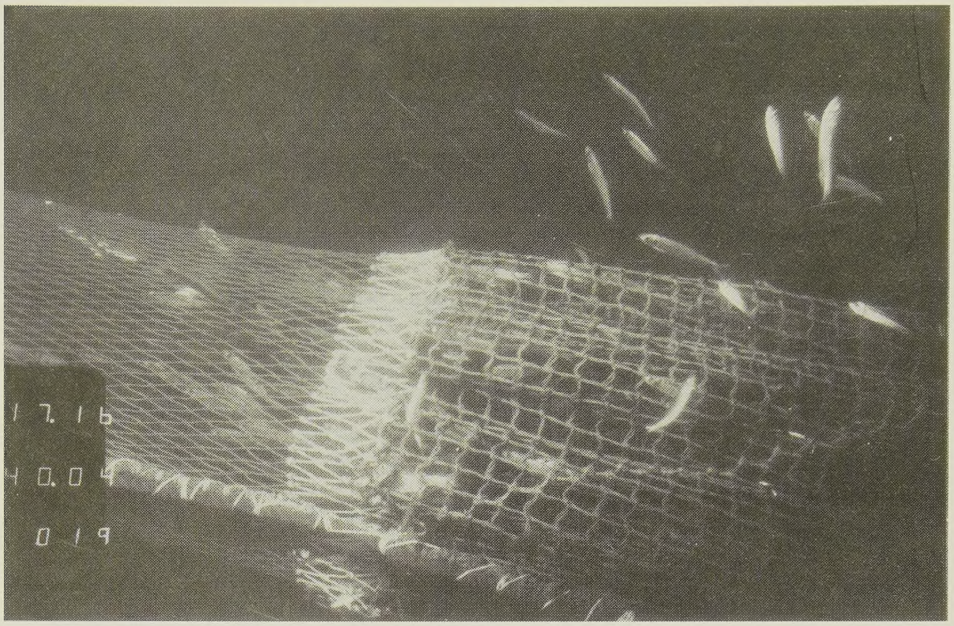

Plate III. The join of a 120 diamond mesh extension piece to a square mesh cod-end with 120 meshes around. The square mesh netting is convoluted. Young herring are escaping.

Bunching of the square meshes occurs because the diameter of such diamond mesh extensions is small. Generally, underwater observations have shown the diamond meshes in the extensions of demersal trawls to be open, on average, 0.25 to 0.15 times the stretched mesh length. This is termed the fractional mesh opening. The actual fishing circumference can be calculated by multiplying the fractional mesh opening by the mesh size by the number of meshes around the extension. The result of using this measurement to calculate the number of bars on the square mesh circumference to match the extension circumference is shown in Plate IV. The meshes are more open and the tube of netting is cylindrical. Matching the diameters of the diamond mesh extension and square mesh cod-end accurately achieves maximum square mesh opening.

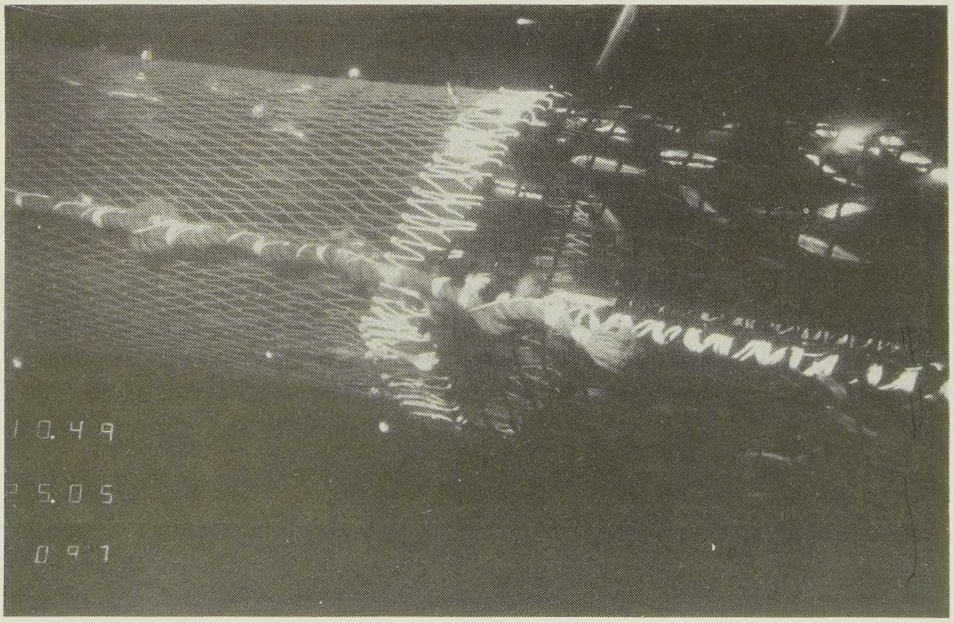

Plate IV. The join of a 120 diamond mesh extension piece to a square mesh cod-end with 60 meshes around. The square meshes are fully open. Young herring are escaping.

Mesh Size

Under present regulations a mesh size less than 80 mm cannot be used in trawl- or seine-nets when fishing for cod, haddock and whiting in European community waters (Statutory Instrument No 256, 1983).

Twine Type and Material

Twisted or braided twines of polyethylene, courlene or nylon are the most commonly used in the Scottish fishery. Knotless or knotted netting can be used but knotless is best. This is because the knots in knotted netting slip and distort the square mesh shape (Plate V) and breakages may occur.

Twisted or braided twine is suitable for square mesh provided that the filaments run continuously through the junction of two twines. This ensures that the tension is supported on all the available twines. A twine thickness of at least 4 mm diameter is recommended for knotless polyethylene netting.

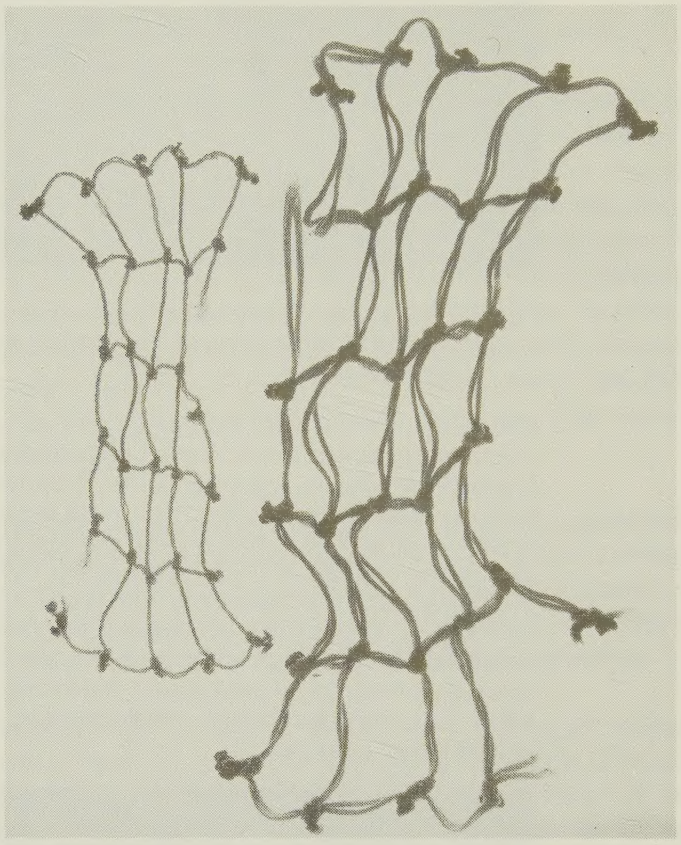

Plate V. Knotted square mesh netting showing the knot slippage which can occur. Samples taken from 60 mm and 80 mm mesh cod-ends.

Overall Length of Square Mesh Cod-ends

Usually 5 to 6 m lengths were used in the selection experiments. Fishermen have also used these lengths. Longer lengths up to 18 m have been observed with underwater television and are satisfactory. At least 6 m long square mesh cod-ends are recommended to give the juvenile fish adequate numbers of open meshes through which to escape.

Diamond mesh cod-ends sometimes tend to twist, stopping fish from reaching the end. The square mesh cod-ends that have been observed do not suffer from this problem.

Cutting Out and Hanging

Sheet netting normally comes off weaving machines with diamond meshes. A square mesh panel is cut out of diamond mesh sheet netting by cutting the four sides of the panel on bars (Fig. 4), leaving waste netting which can be re-used if all the spare pieces are braided together, but this creates extra

work. Alternatively, some netting manufacturers machine braid cylinders of square mesh netting which have no joins or selvedges. These cylinders of netting obviate the need to cut out sections which then have to be joined together.

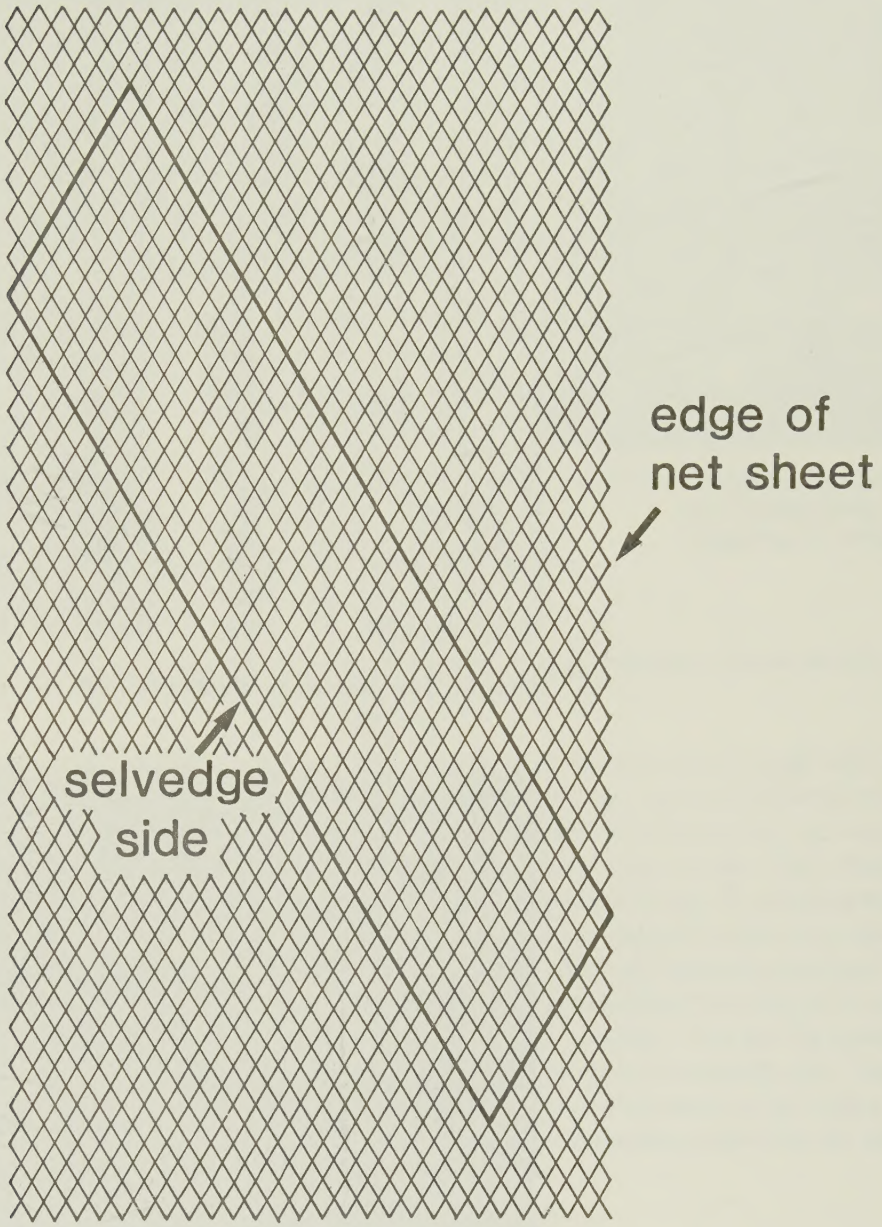

Figure 4. The method for cutting a square mesh cod-end panel from diamond mesh netting.

In a two panel cod-end the edges need to be joined or selvedged together. Care must be taken to hang the meshes squarely before lacing (Plate VI). The distortion caused by not doing so is shown in Plate VII.

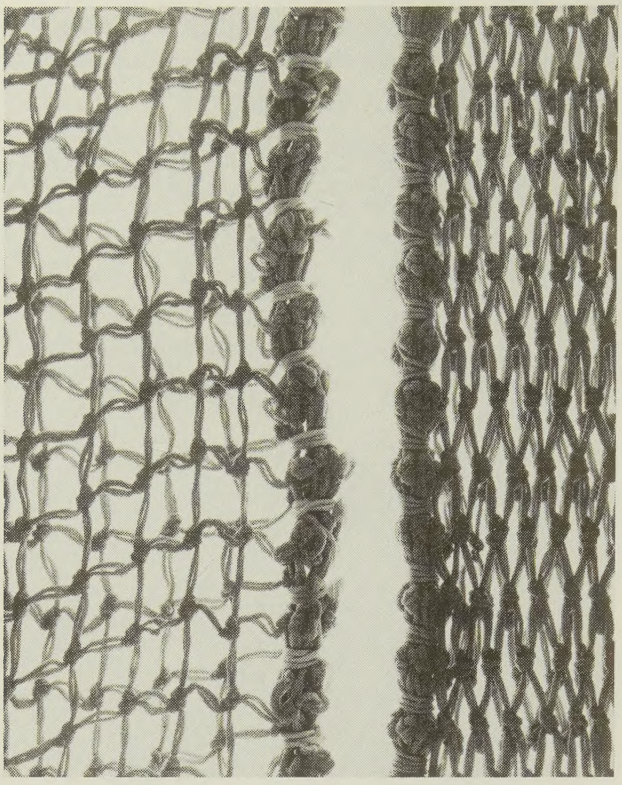

Plate VI. Examples of the selvedges from 90 mm square (left) and diamond (right) mesh cod-ends.

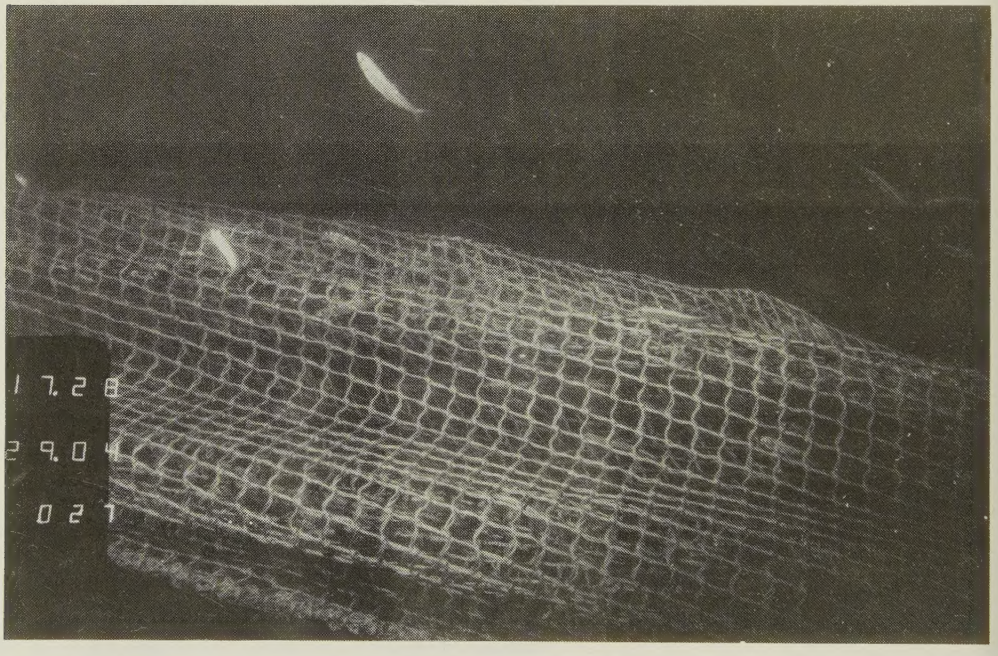

Plate VII. A distorted square mesh cod-end caused by selvedging one side incorrectly. Young herring are escaping.

Lifting Strops

Square mesh cod-ends tend to lift more fish aboard than diamond mesh cod-ends of the same size if the lifting strop is placed the same distance from the cod-line. To avoid lifting too heavy a load the lifting strop should therefore be placed about 1.2 m above the cod-line. This will ensure that about 20 to 30 baskets (50 kg in one basket) of fish are lifted in a cod-end having 80 mm mesh and 120 bars on its circumference (Plate VIII(i) and (ii)). The lifting strop should be long enough not to constrict the cylinder of netting.

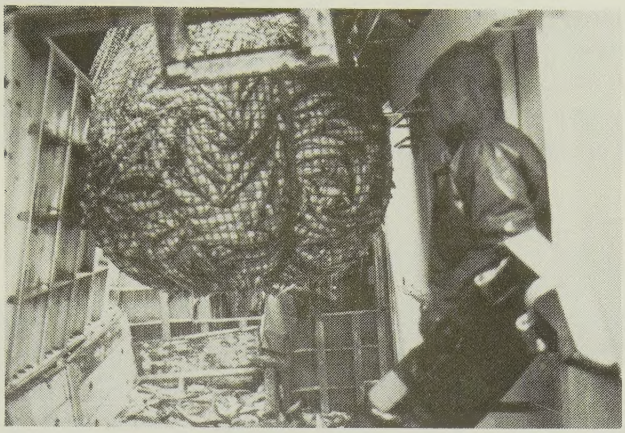

Plate VIII. (i) A square mesh cod-end containing two tonnes of whiting and haddock.

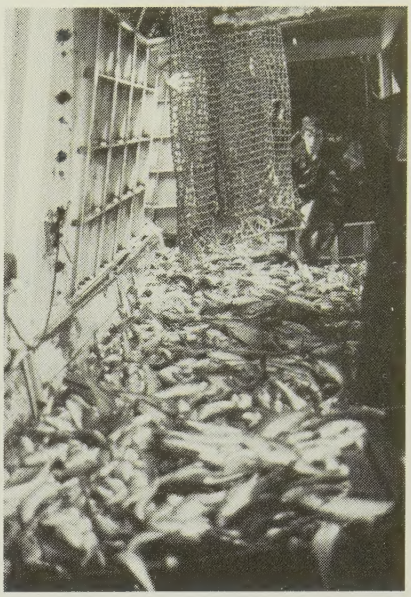

Plate VIII. (ii) The same square mesh cod-end after unloading the contents.

Plates VIII (i) and (ii) were taken on the Scottish fishing vessel Boy Andrew WK171.

Cod-line Meshes

The cod-line needs extra meshes at the end of the cod-end through which it is reeved. The cod-line meshes should be one or two rows of diamond mesh braided onto the last row of square mesh. These meshes must not be too large, as they can allow fish to escape, nor should they be too small, because the cod-line will not be able to close the bunched netting. To avoid large amounts of bunched netting the selvedges can be tapered toward the cod-line (Fig. 5). However with both the tapered and non-tapered selvedges it may still be difficult to close the cod-line. A second cod-line may then be needed three or four meshes up from the first cod-line. This can be reeved directly through the cod-end meshes and fastened with a Dutch clip. The tension of a cod-end full of fish bearing down on this cod-line can make it very difficult to undo a rope knot. The clip is therefore preferable for easy unfastening.

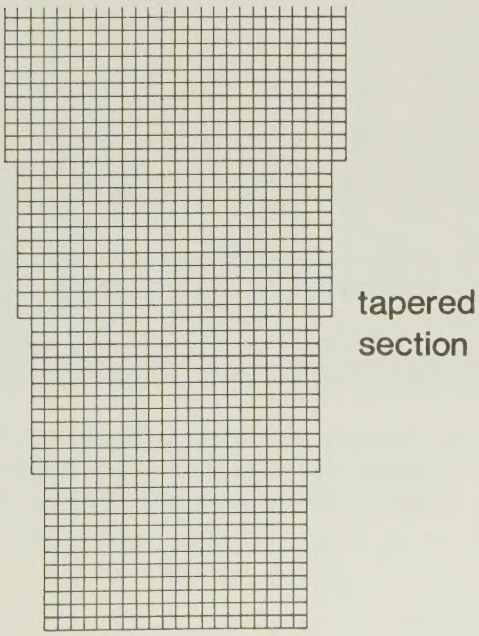

Figure 5. Tapered square mesh netting.

Joining to the Extension

The front end meshes of the cod-end must be prevented from pulling apart. Plate IX demonstrates what can happen if they are not. The twines can slip and the cod-end join may thus be undone and the cod-end lost. The joins of the twines must be fastened by heat setting combined with running a twine around the circumference of the cod-end as in Plate X.

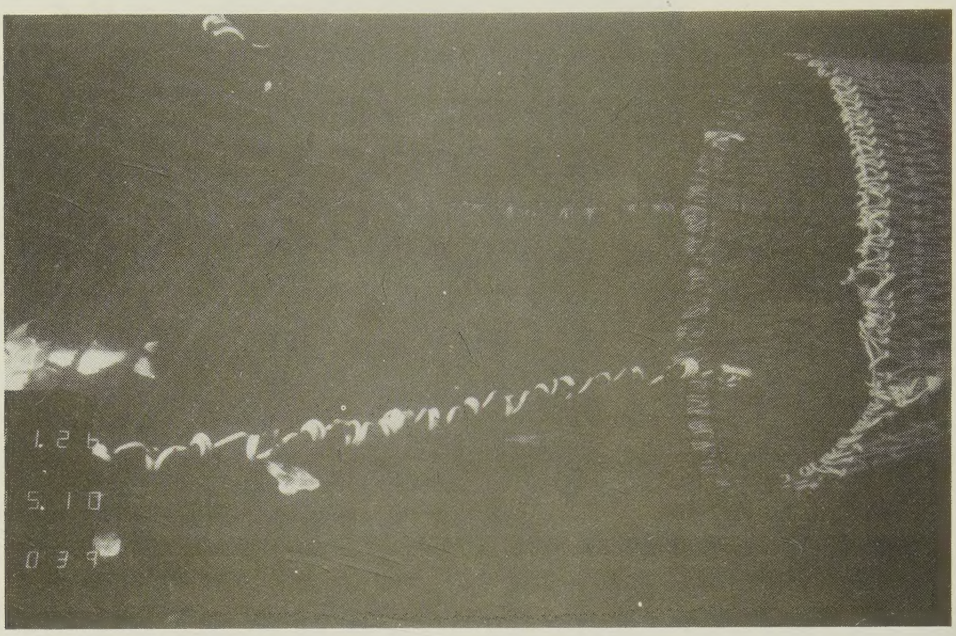

Plate IX. The result of failure of knotless square mesh netting at a join to diamond mesh netting.

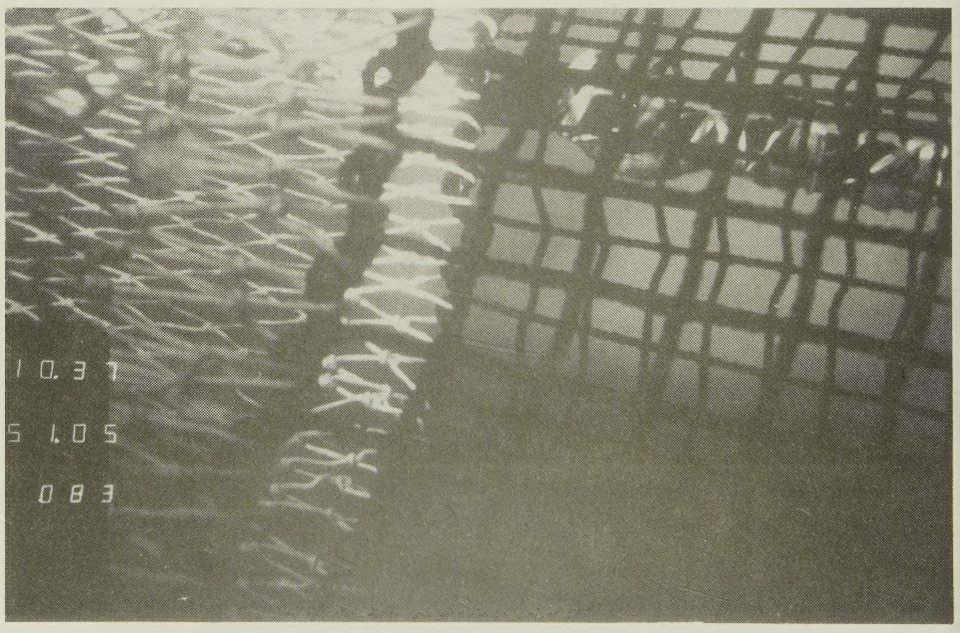

Plate X. In order to solve the problem shown in Plate IX, the first row of square meshes has been tied back onto the leading edge of the second row. An extra twine has also been run round the circumference.

Square mesh cod-ends are joined to diamond mesh extensions by braiding. It is best to knot the joining twine to each of the diamond meshes. The twine need only be looped through the square meshes but it is best to knot every third or fourth mesh (Plate XI).

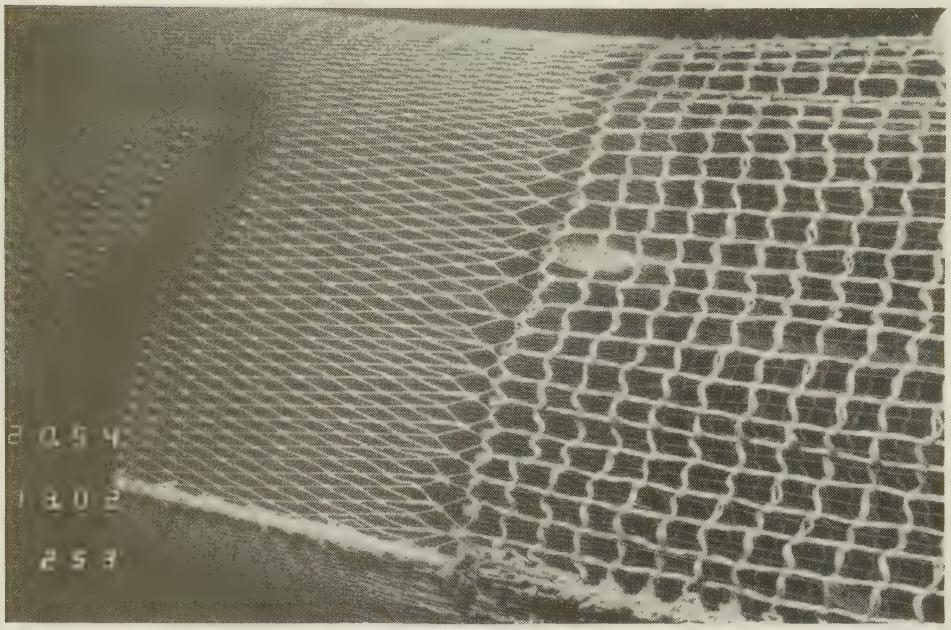

Plate XI. Joining diamond and square meshes. The joining twine is knotted to the diamond meshes and looped through the square meshes with an occasional knot.

Strength of Square Mesh Cod-ends

The breaking strengths of small samples of square and diamond mesh netting have been tested (Robertson and Polanski, 1984). Four mesh sizes from 60 to 130 mm were compared. Knotted netting was used throughout and the samples measured four meshes by four meshes. Square mesh with single twine had about one third, and double twine one half of the breaking strength of diamond mesh with the same twine diameter. Nevertheless, square mesh cod-ends can lift up to two tonnes of fish aboard a vessel if the twine is thick enough, ie with 120 meshes around and 80 mm mesh double polyethylene twine of 3.5 mm diameter (Plate VIII). A cod-end with the properties of the weakest sample tested, ie 60 mm mesh single twisted polyethylene, runnage 328 m kg, would have a safety factor of about two when lifting a typical bag of one and a half tonnes of fish aboard a boat. A safety factor of five is more typical when using diamond mesh netting. A minimum factor of five is advisable to compensate for the surging effect and subsequent increased loading on full square mesh cod-ends during vessel rolling. A 50% increase of twine diameter in the square mesh would compensate for the loss in strength (see Robertson and Polanski, 1984).

Acknowledgements

Grateful appreciation is extended to Alvan Rice for Figures 1 to 5, and to T G McInnes for Plates V and VI.

References

Robertson, J.H.B. 1982. Square and hexagonal mesh cod-end design tests on FRV "Goldseeker" and commercial trials results with square mesh cod-ends on "Gem", "Janeen II" and "Harvest Reaper". Scottish Fisheries Working Paper 1982, No 3, 11 pp.

References (Contd.)

Robertson, J.H.B. 1983a. Square mesh cod-end selectivity experiments on whiting (*Merlangius merlangus* (L.)) and haddock (*Melanogrammus aeglefinus* (L.)). International Council for the Exploration of the Sea, CM1983/B:25, 4 pp. (mimeo).

Robertson, J.H.B. 1983b. Square and diamond mesh cod-end selectivity on haddock (*Melanogrammus aeglefinus* (L.)) using the alternate haul technique. Scottish Fisheries Working Paper 1983, No. 3, 4 pp.

Robertson, J.H.B. 1984. Square mesh cod-end selectivity for haddock (*Melanogrammus aeglefinus* (L.)) and whiting (*Merlangius merlangus* (L.)) in a Scottish seine net. International Council for the Exploration of the Sea, CM1984/B:30, 5 pp. (mimeo).

Robertson, J.H.B. and Polanski, J. 1984. Measurement of the breaking strength of square and diamond mesh netting. Scottish Fisheries Working Paper 1984, No. 9, 3 pp.

Robertson, J.H.B., Emslie, D.C., Ballantyne, K.A. and Chapman, C.J. 1986. Square and diamond mesh trawl cod-end selection trials on *Nephrops norvegicus* (L.). International Council for the Exploration of the Sea, CM1986/B:12, 5 pp. (mimeo).

Robertson, J.H.B. and Stewart, P.A.M. 1986. An analysis of length selection data from comparative fishing experiments on haddock and whiting with square and diamond mesh cod-ends. Scottish Fisheries Working Paper 1986, No. 9, 8 pp.

Statutory Instrument No 256. 1983. The Sea Fishing (Enforcement of European Economic Community Conservation Measures) Order 1983. 8 pp.

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